

SHIP PRODUCTION COMMITTEE  
FACILITIES AND ENVIRONMENTAL EFFECTS  
SURFACE PREPARATION AND COATINGS  
DESIGN/PRODUCTION INTEGRATION  
HUMAN RESOURCE INNOVATION  
MARINE INDUSTRY STANDARDS  
WELDING  
INDUSTRIAL ENGINEERING  
EDUCATION AND TRAINING

June 1977  
NSRP 0003

# **THE NATIONAL SHIPBUILDING RESEARCH PROGRAM**

## **Proceedings of the REAPS Technical Symposium**

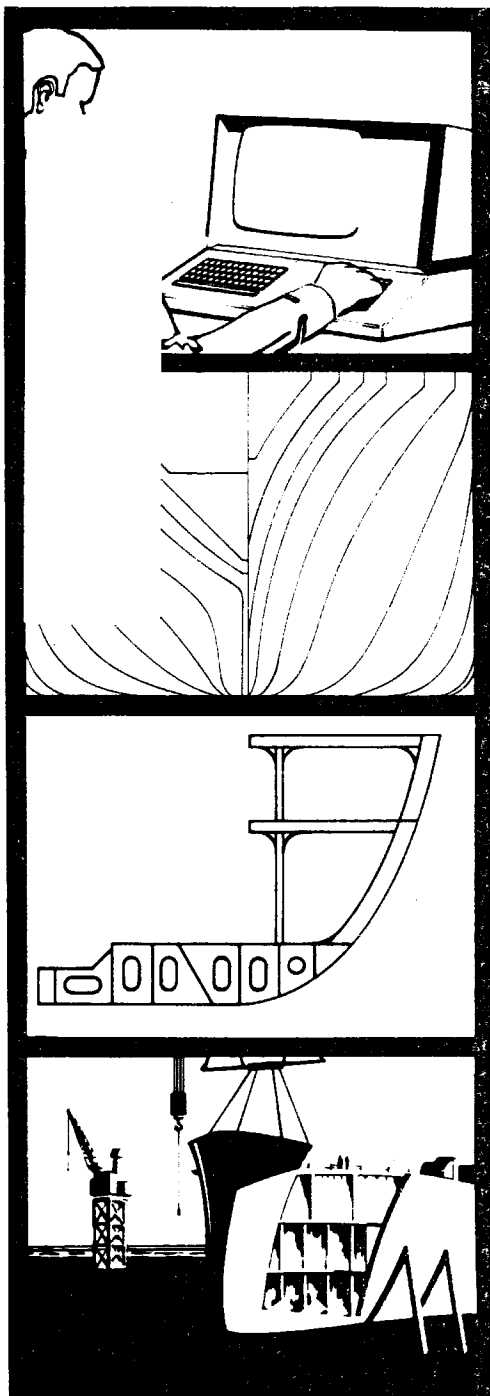
### **Paper No. 4: Computer-Aided Engineering and Drafting in Shipbuilding**

U.S. DEPARTMENT OF THE NAVY  
CARDEROCK DIVISION,  
NAVAL SURFACE WARFARE CENTER

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**R** ESEARCH  
**E** AND  
**E** NGINEERING  
**A** FOR  
**A** UTOMATION  
**P** AND  
**S** RODUCTIVITY  
IN  
SHIPBUILDING

**Proceedings of the  
REAPS Technical Symposium  
June 21-22, 1977  
New Orleans, Louisiana**

## COMPUTER-AIDED ENGINEERING AND DRAFTING IN SHIPBUILDING

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Computervision Corporation  
Bedford, Massachusetts

As Manager, Federal Systems, Dr. Cowan is responsible for sales and technical coordination of all major federal projects in Maryland, Virginia and the District of Columbia. . Before joining Computervision, he was President of Applied Programming Technology (a Gerber Scientific subsidiary) and also performed independent software contracting and consulting.

Dr. Cowan has a B.S. degree from Brown University and M.S. and Ph.D. degrees from Case Institute of Technology.

# PROBLEMS COMPANIES FACE TODAY

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- HIGH COST OF CREATING DESIGN DOCUMENTATION
- RISING COST OF MANPOWER
- TIME WASTED ON TEDIOUS REPETITIVE TASKS
- LACK OF STANDARDIZATION
- PEAK WORK LOAD SITUATIONS
- REJECTED FINISHED PARTS
- TRIAL AND ERROR APPROACH TO PARTS PROGRAMMING
- LONG PRODUCT LEAD TIMES

## RESULT OF THESE PROBLEMS

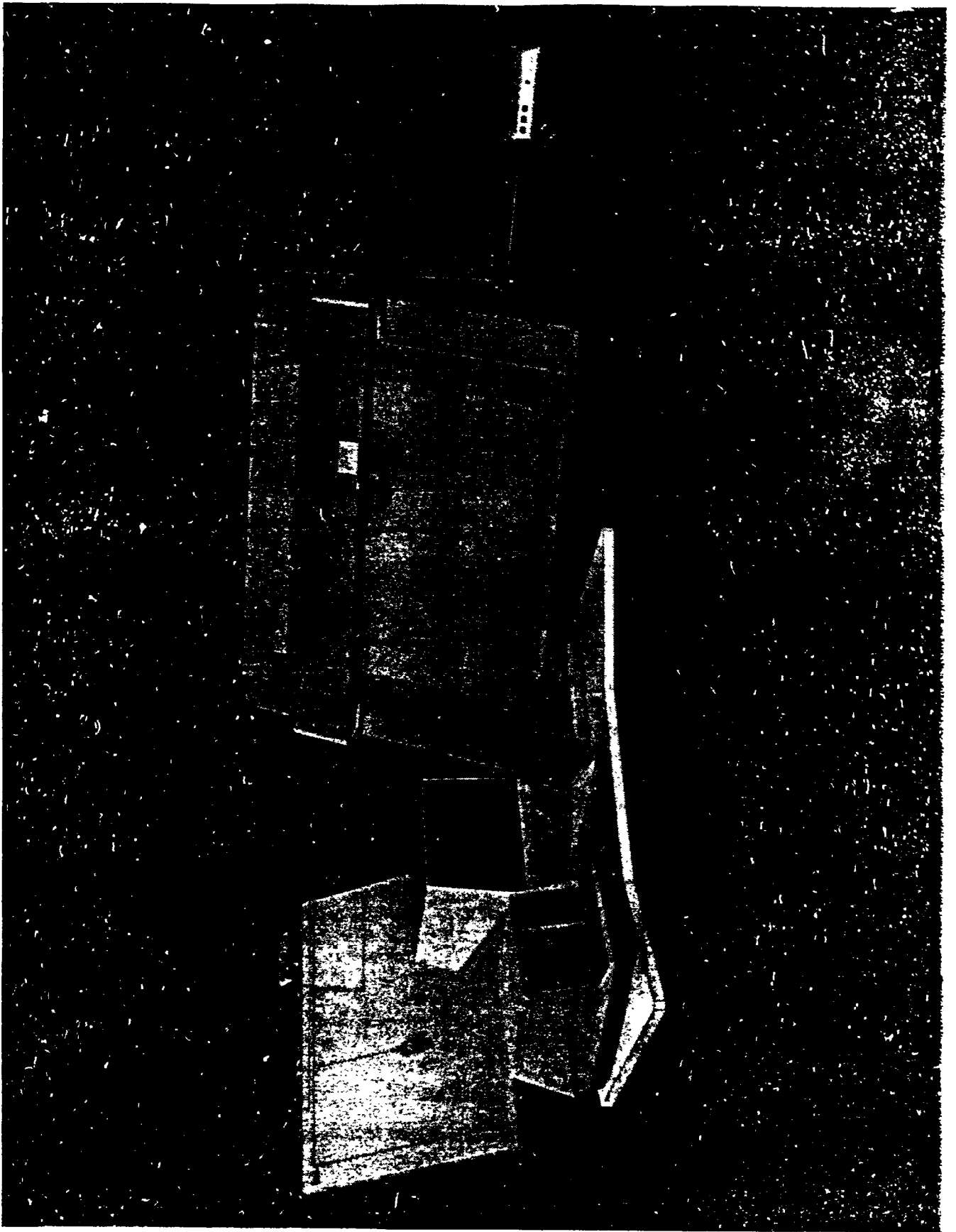
- WASTED COMPANY RESOURCES

## RESULTING IN

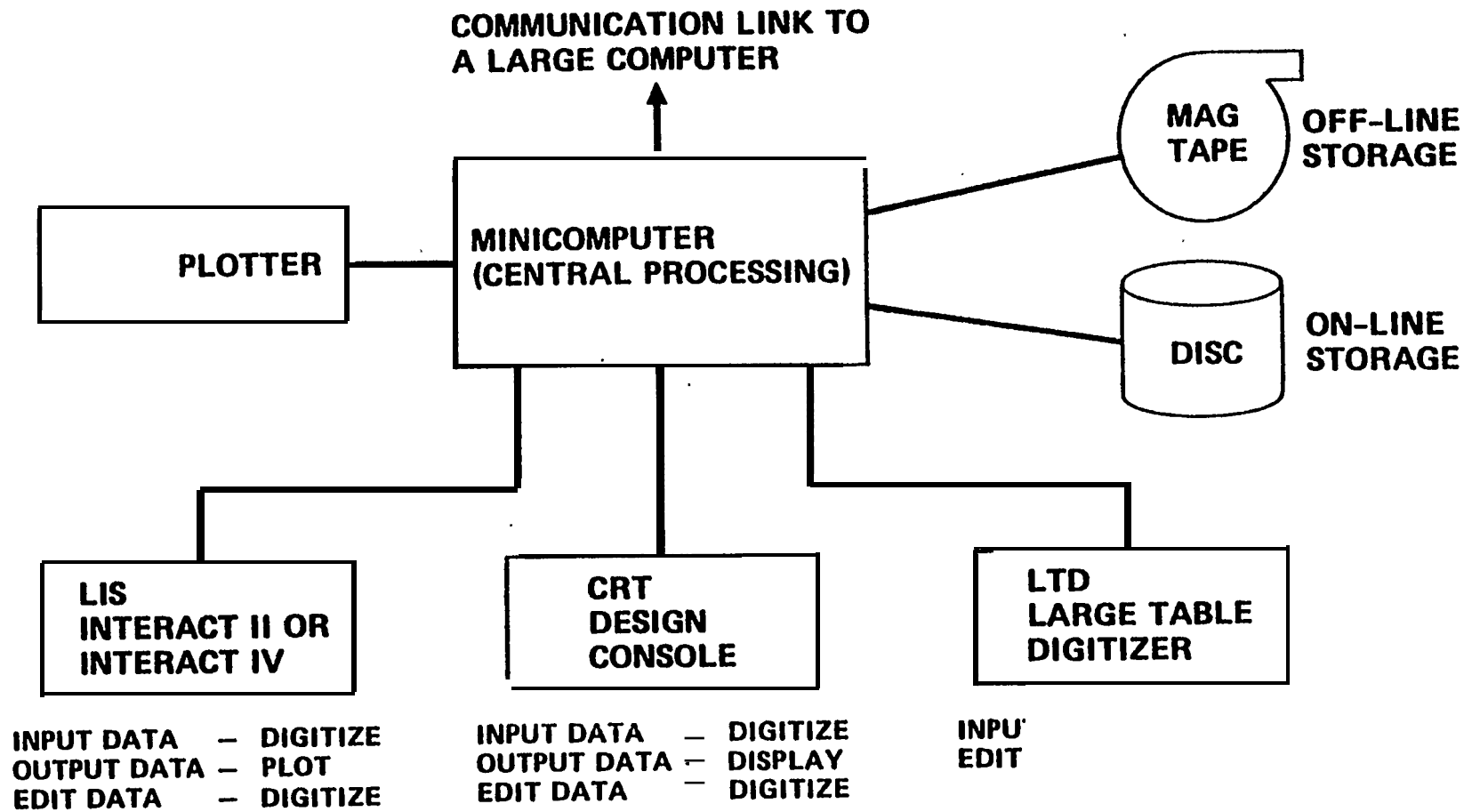
- INCREASED PRODUCT COST
- REDUCED PRODUCTION
- REDUCED COMPETITIVE POSITION

## BOTTOM LINE .

- LOST \$\$'s



# FUNCTIONAL SYSTEM DIAGRAM





# SYSTEM HARDWARE AND SOFTWARE

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## HARDWARE

PLOTTER/DIGITIZERS

CRT's

DIGITIZERS

PHOTOPLOTTERS

AUTOMATIC SCANNER

PLOTTERS

FULL RANGE OF COMPUTER  
PERIPHERALS

## SOFTWARE

100% FORTRAN BASED

SIMULTANEOUS, COMPATIBLE 3D AND 2D DATA BASES

SIMULTANEOUS, MULTI-APPLICATION

PEP

DATA BASE MANAGEMENT

MULTI-TERMINAL OPERATING SYSTEM AND FILE  
MANAGER

OPTIMIZED MAN-MACHINE INTERFACE

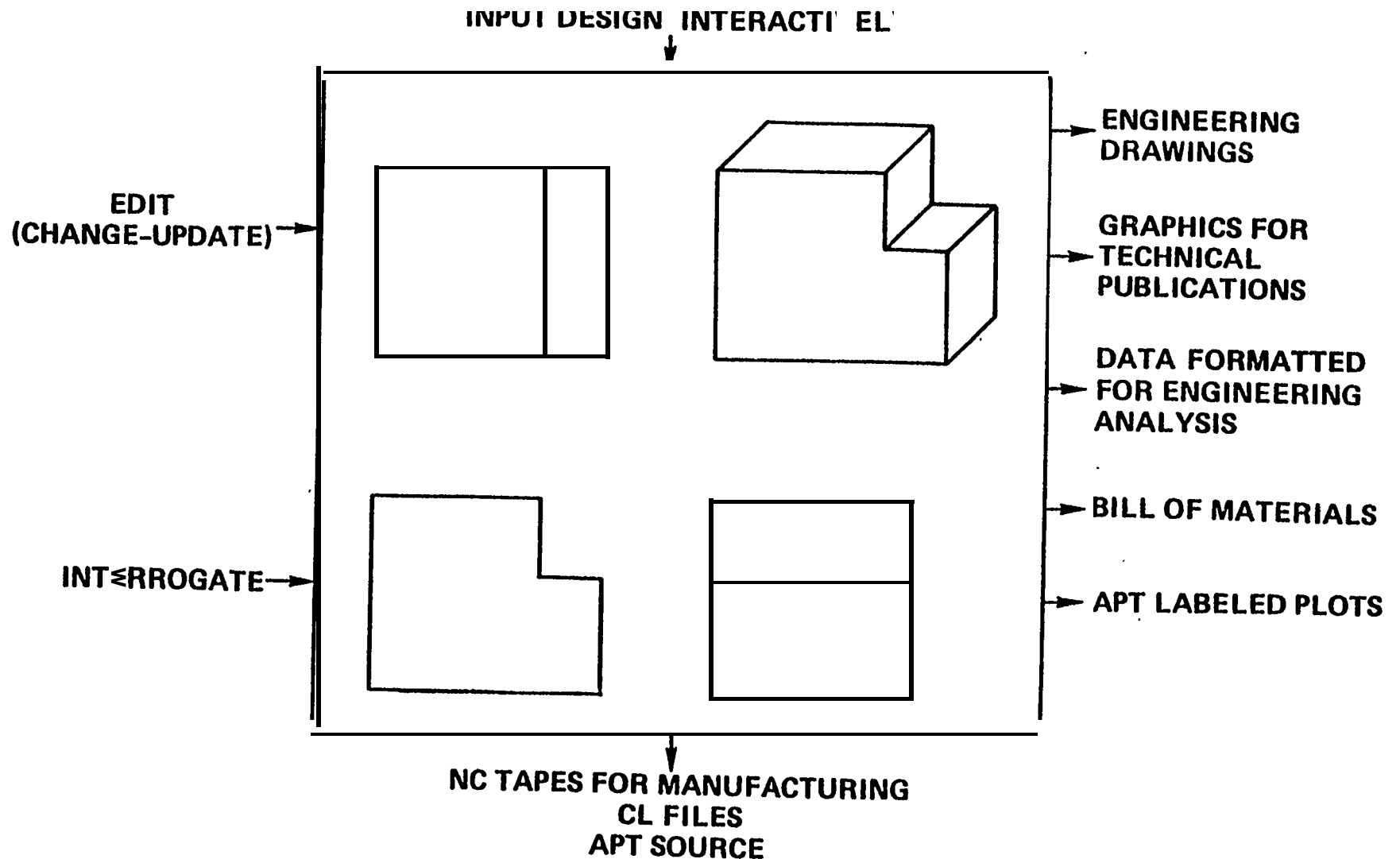
SELF-TUTORING

FORTRAN COMPILER

NC POST PROCESSORS

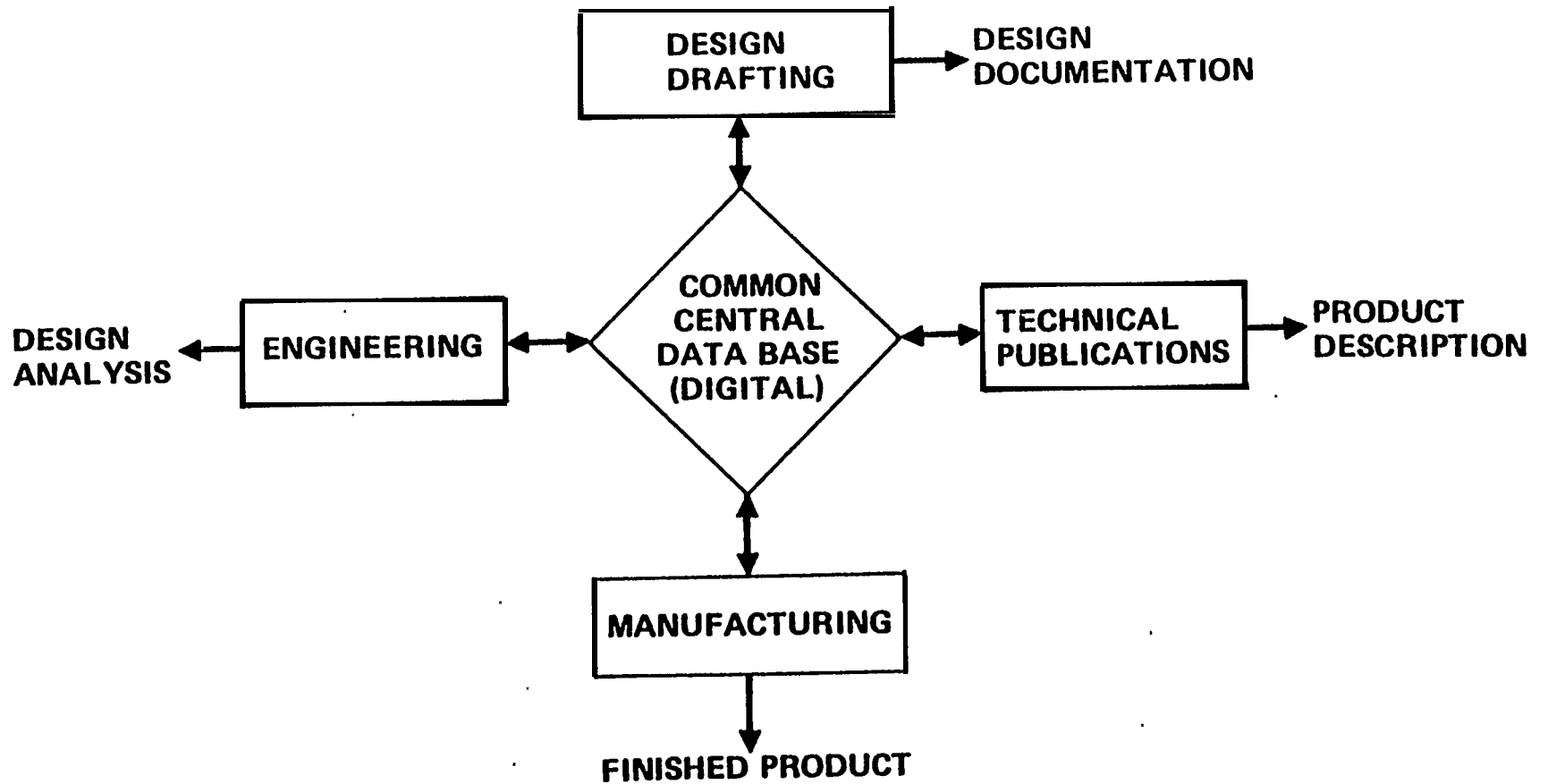
ACCOUNTING FEATURES

# 3D MD/NC SYSTEM OVERVIEW



# CENTRAL DATA BASE CONCEPT

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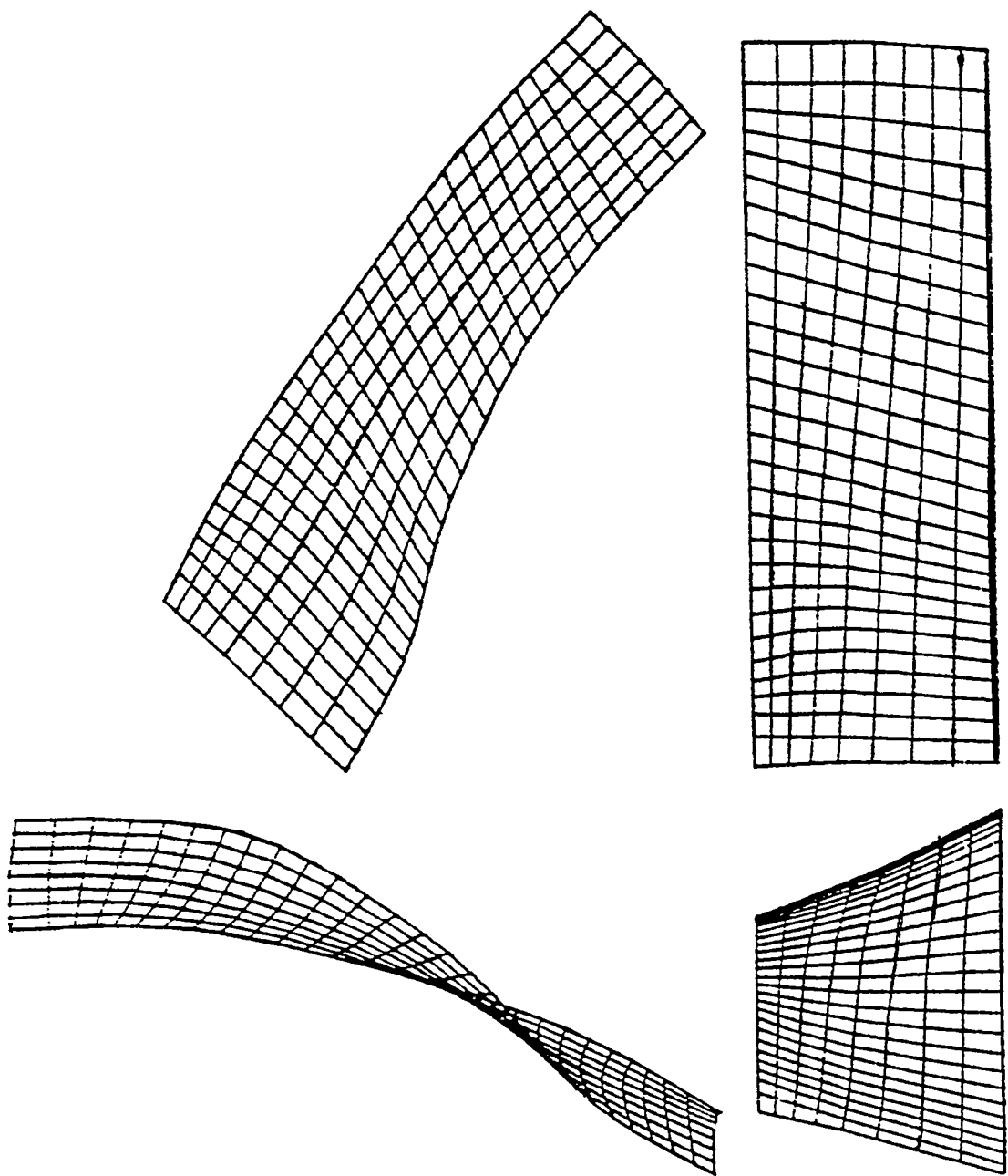
# DESIGN ON INTERACTIVE GRAPHIC SYSTEMS

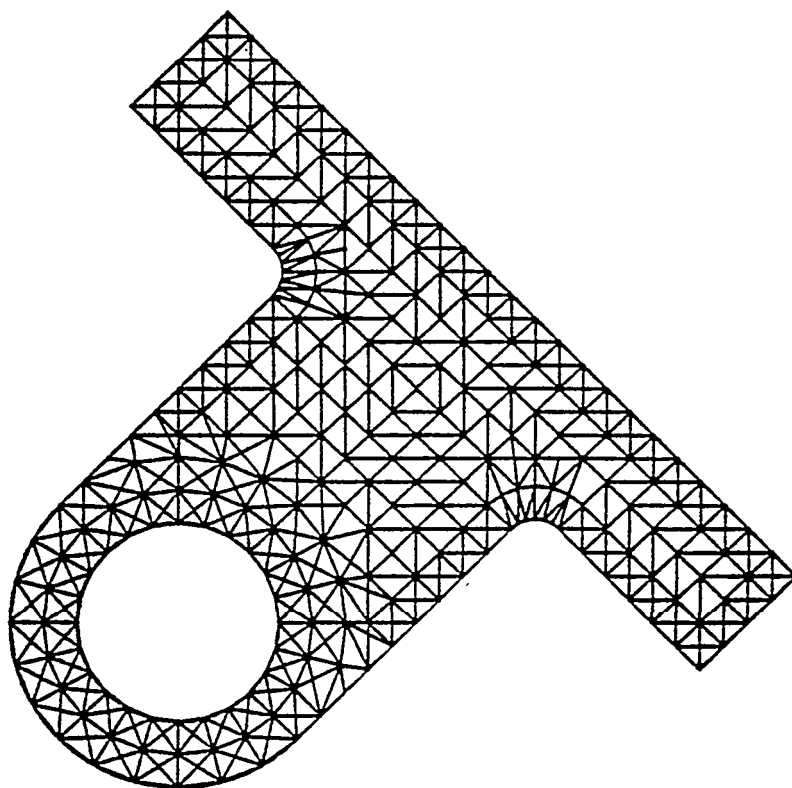
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- AREA, PERIMETER, LENGTH, VOLUME, DENSITY, WEIGHT
- 3D DISTANCE
- MINIMUM DISTANCE
- INTERSECTING LINES
- INTERSECTING LINES AND PLANES
- INTERFERENCE AND CLEARANCE
- TOLERANCE STACKING
- STRESS, STRAIN, THERMAL EXPANSION
- FIT PARTS TOGETHER
- CROSS-SECTION
- INTERSECTION OF SURFACES

+

ALL THE GEOMETRIC CONSTRUCTIONS





# **DRAFTING ON INTERACTIVE GRAPHIC SYSTEMS**

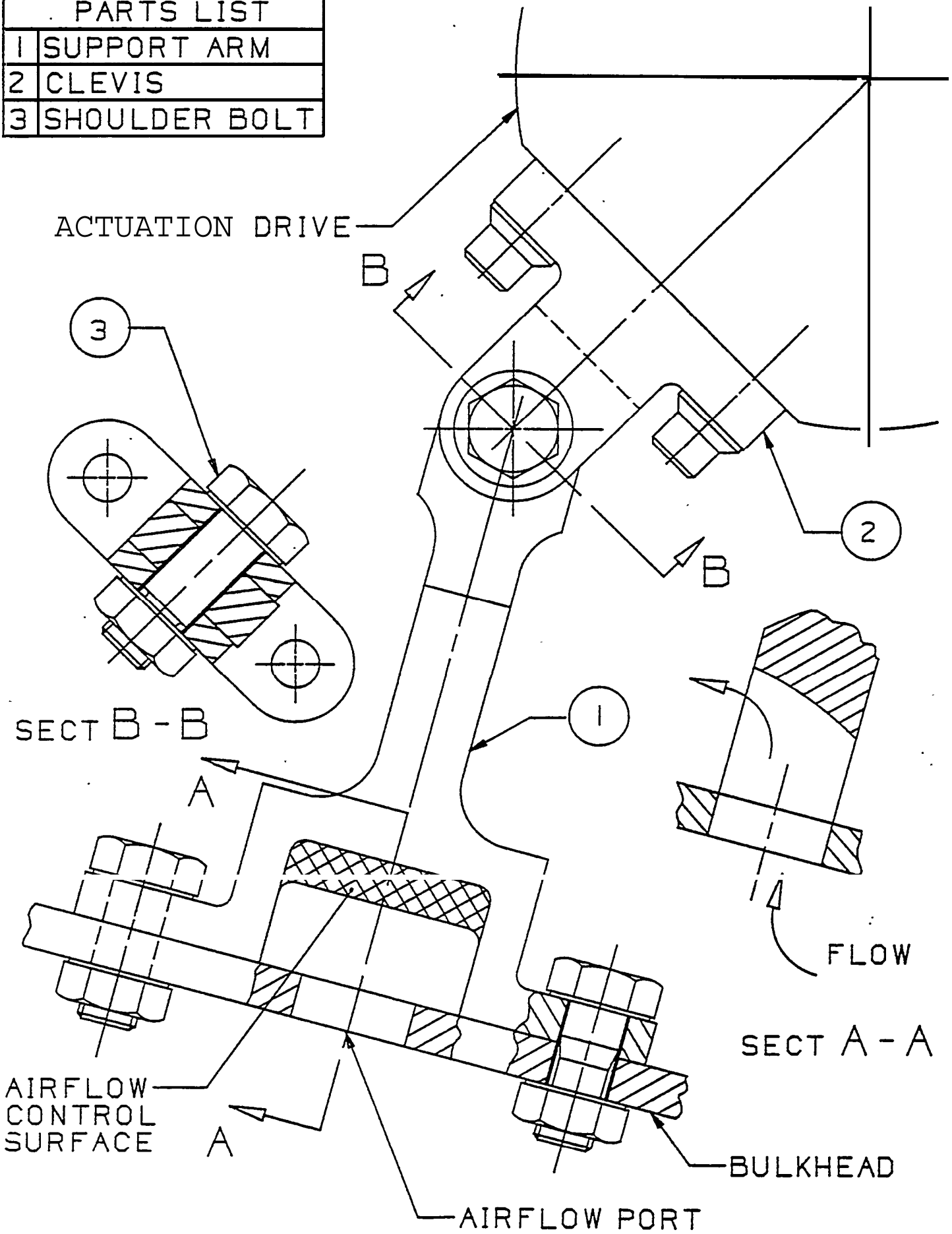
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- ISOMETRIC VIEWS**
- CROSS-SECTIONS**
- DIMENSIONING (ENGLISH & METRIC)**
- CROSS-HATCHING**
- FILLETS**
- FEATURE CONTROL SYMBOLS**
- SCALE, COPY, ROTATE, MIRROR, DELETE ETC.**

**ONCE DESIGN IS COMPLETED THE DRAFTSMAN CAN EASILY  
CREAT FINISHED DRAWINGS OF PARTS AND ASSEMBLIES**

- HIGHER QUALITY DRAWINGS**
- IN A SHORTER PERIOD OF TIME**
- AT A REDUCED COST**

PARTS LIST	
1	SUPPORT ARM
2	CLEVIS
3	SHOULDER BOLT





# BASIC GEOMETRY

---

POINT

LINE

STRING

CIRCLE

ARC

GROUPS

FILLET

SPLINE  
(CUBIC)

CONICS

(ELLIPSE)

(HYPERBOLA)

(PARABOLA)

ARRAYS

(RECTANGULAR)

(CIRCULAR)

# EXTENDED GEOMETRY

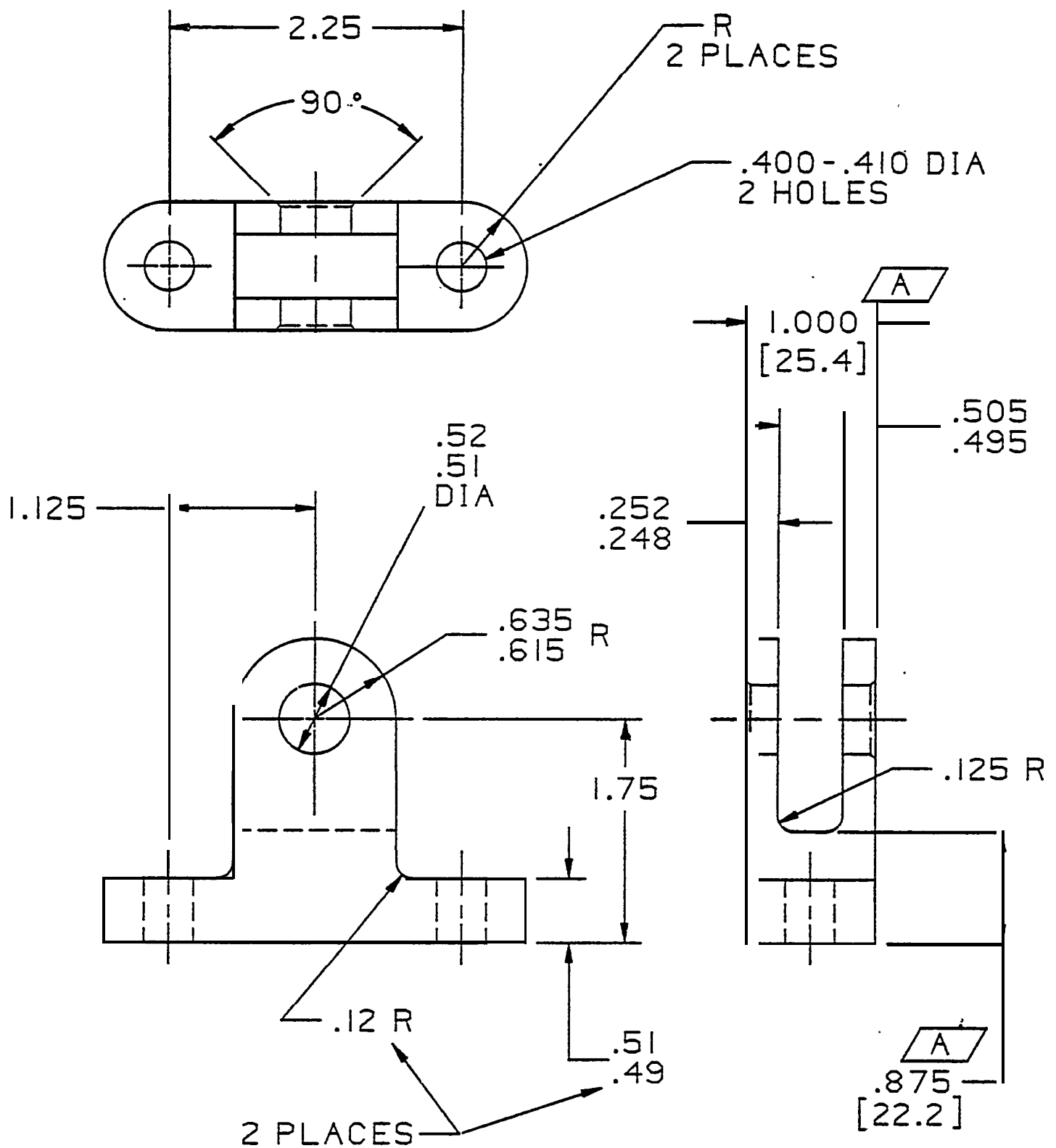
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- TABULATED CYLINDERS
  - RULED SURFACES
  - SURFACES OF REVOLUTION
  - B-SURFACES
  - MESH SURFACES
  - SURFACE INTERSECTIONS

# AUTOMATIC DIMENSIONING


---

- ENGLISH/METRIC
- HORIZONTAL
- VERTICAL
- RADIAL
- DIAMETER
- ANGULAR
- PARALLEL POINTS (DIMENSIONS AT AN ANGLE)
- AUTOMATIC TOLERANCING
- ANS Y14.5



### GENERAL NOTES

1 — DIM SPECIFIED MUST BE MAINTAINED.

2 —  DIM SHOWN IN ENGLISH AND METRIC FORM.

# PEP PROGRAM (WEDGE)

```
PEP' JRIIS. WEDGE
SOURCE VERSION # 137 7-11-75
OBJECT VERSION **NONE**

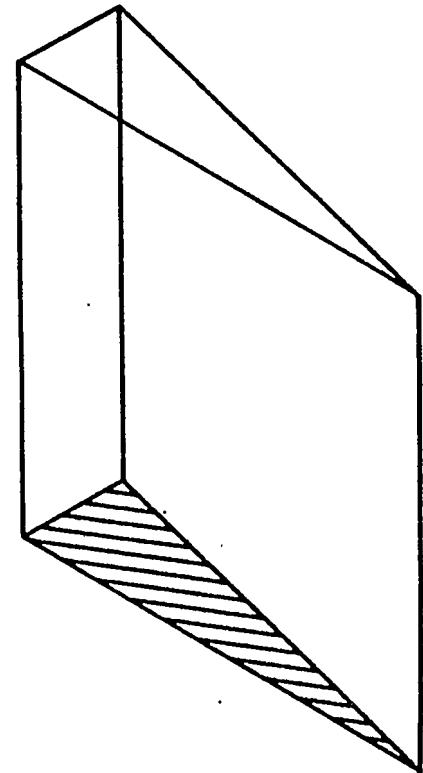
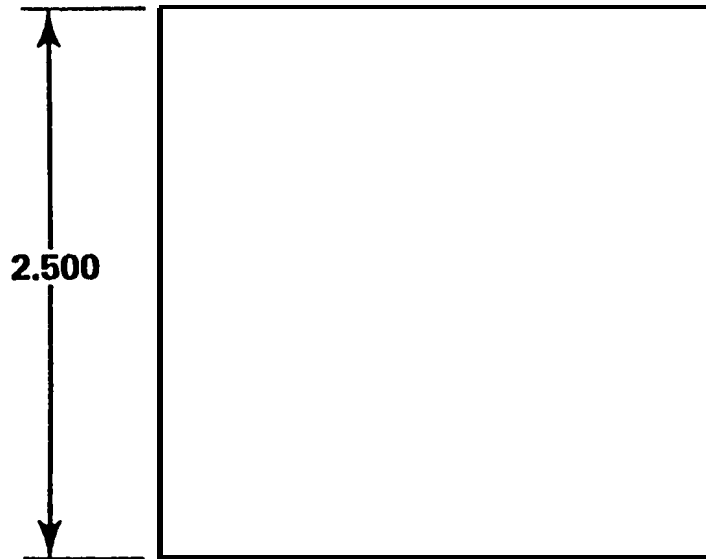
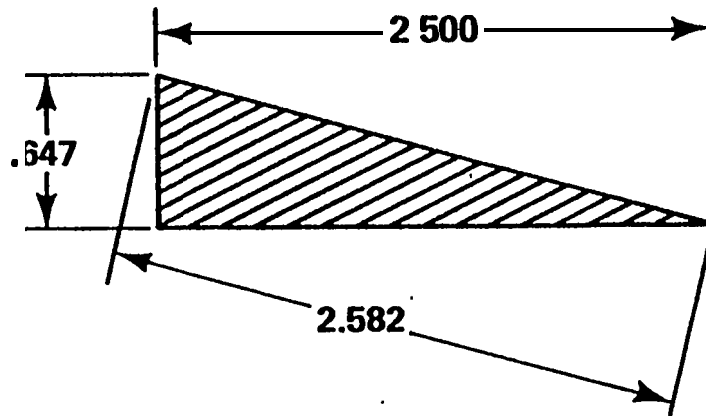
11  PARTNO/WEDGE
21  $PARAMETERS
31  A=2 .5          $LENGTH          FORTRAN          PARAMETERS
41  B=A*COS (75)    $THICK           CONSTANTS
51  C=2 .5          $CONSTANT
61  D=.2            $DENSITY
71  $PART DEFINED

81  L1=LINE/0,0,A,0
91  L2=LINE/A, O, O, B
101 L3=uNE/o, B,o, o          APT TYPE          GRAPHICS
111 L4=LINE/o, o,o, o,o, c    STATEMENTS
121 L5=LINE/o, o,c, A,o, c
131 L6=LI NE/A, O,C, A, 0,0
141 L7=LINE/A, O,C, O, B, C
151 L8=LINE/0, B,C, O, B, O
161 L9=LINE/0, B, C, 0,0, C

171 AREA=A*B/2
181 VOLU=AREA*D          FORTRAN          CALCULATIONS
191 WGT=VOLU*D
201 PRINT/AREA, VOLU, WGT
211 FILE
221 FINI
```

## THE FOUR VIEWS OF A WEDGE, RESULTED FROM EXECUTING THIS PROGRAM

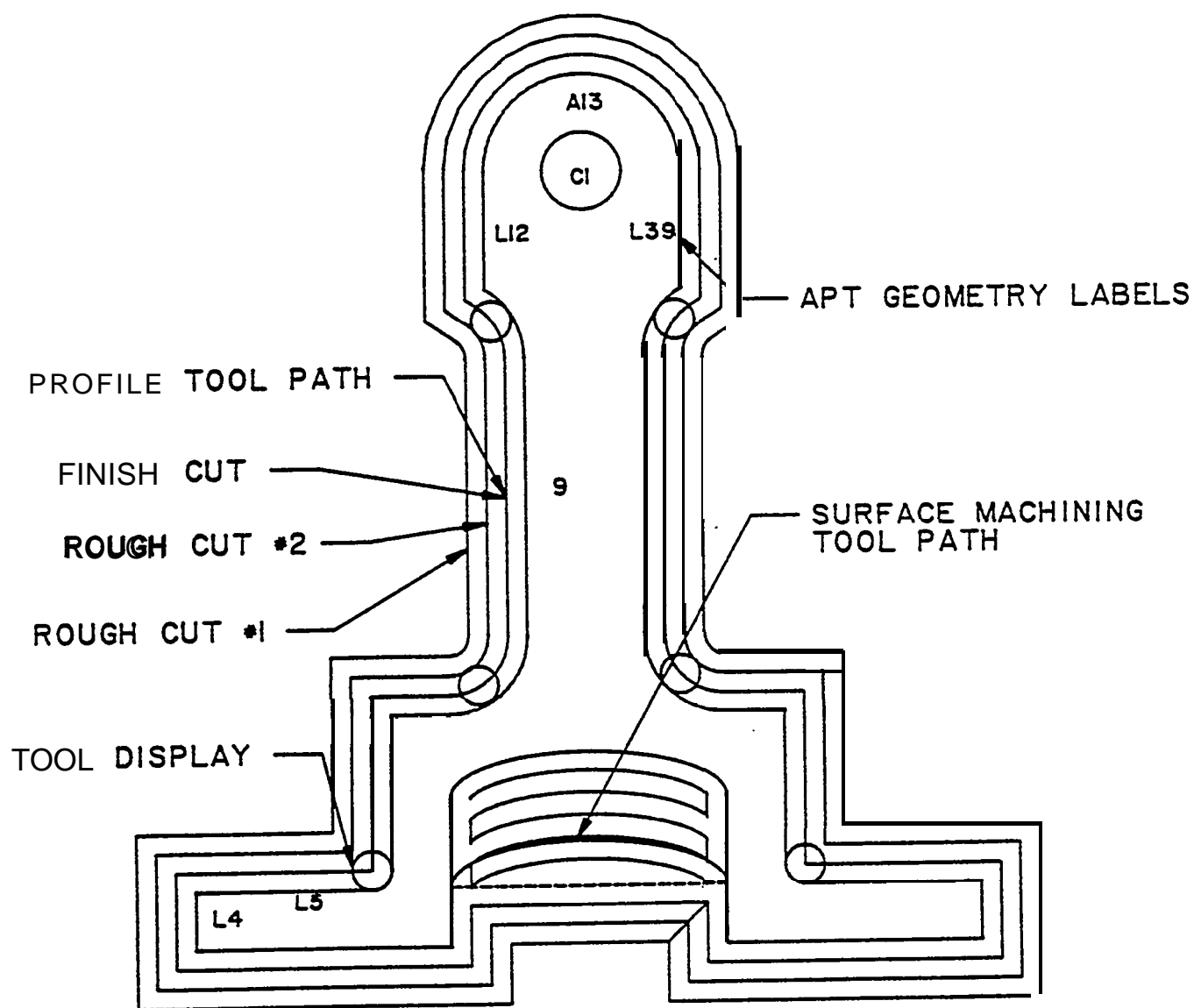
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# NUMERICAL CONTROL

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- GRAPHIC TOOL PATH DERIVATION
- UP TO 5-AXIS CAPABILITY
- POCKETING
- PROFILING
- POINT TO POINT
- ABSOLUTE AND SURFACE MACHINING
- APT SOURCE, APT GEOMETRIC SOURCE, APT LABEL PLOT  
(AUTOMATIC TAGGING), CL FILES, NC TAPES
- POST PROCESSORS
- MAGNETIC OR PAPER TAPE OUTPUT





# HOW DO PEOPLE INTERFACE WITH THE SYSTEM?

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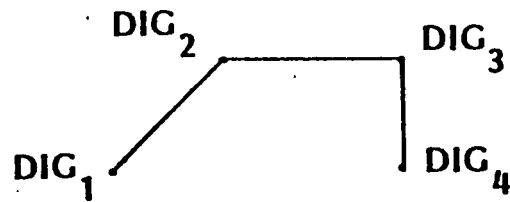
- NO COMPUTER KNOWLEDGE REQUIRED
- EASY TO LEARN ENGLISH LANGUAGE COMMANDS
- SELF-TUTORING

# COMMAND LANGUAGE

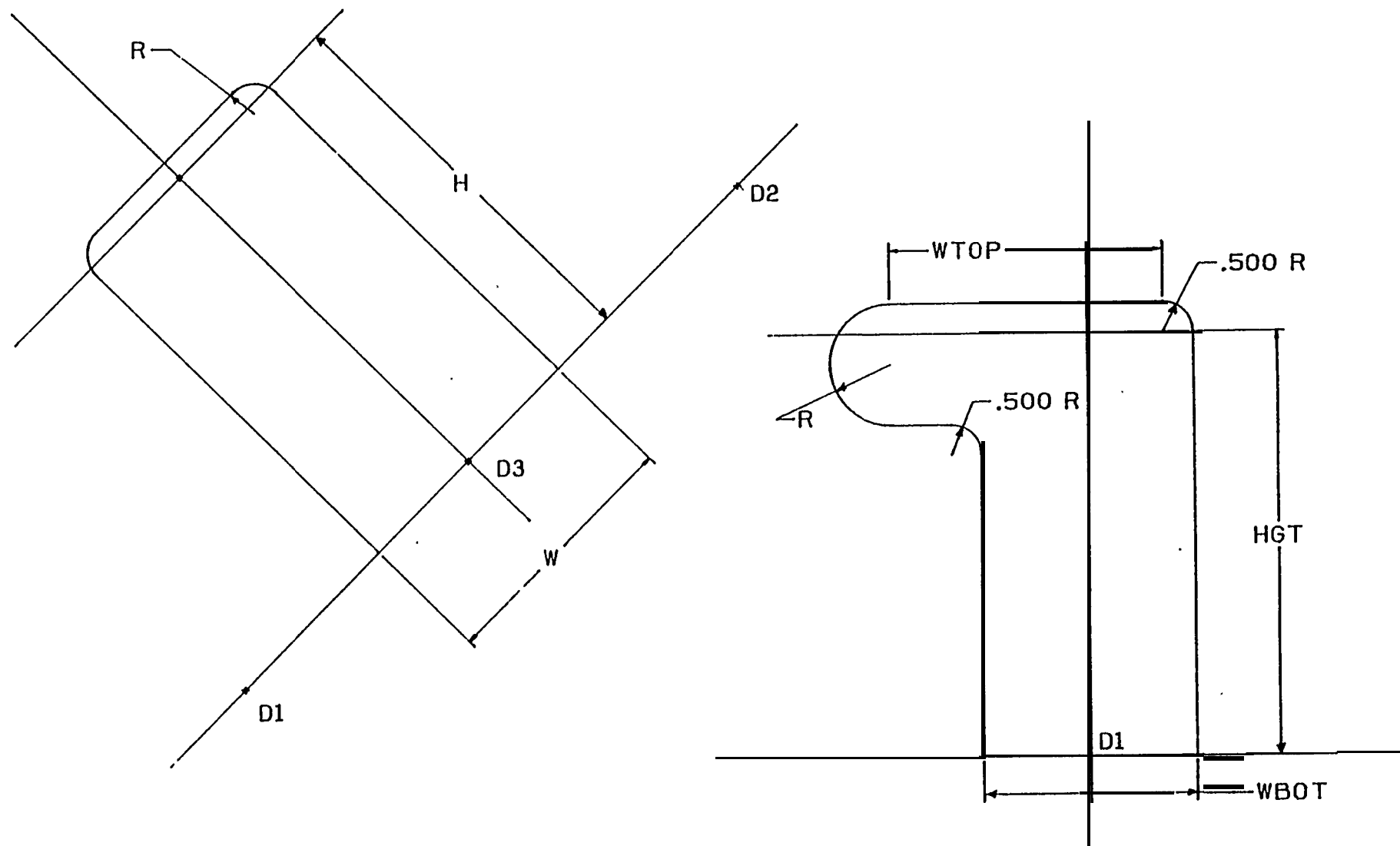
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VERB NOUN: DIGITIZE

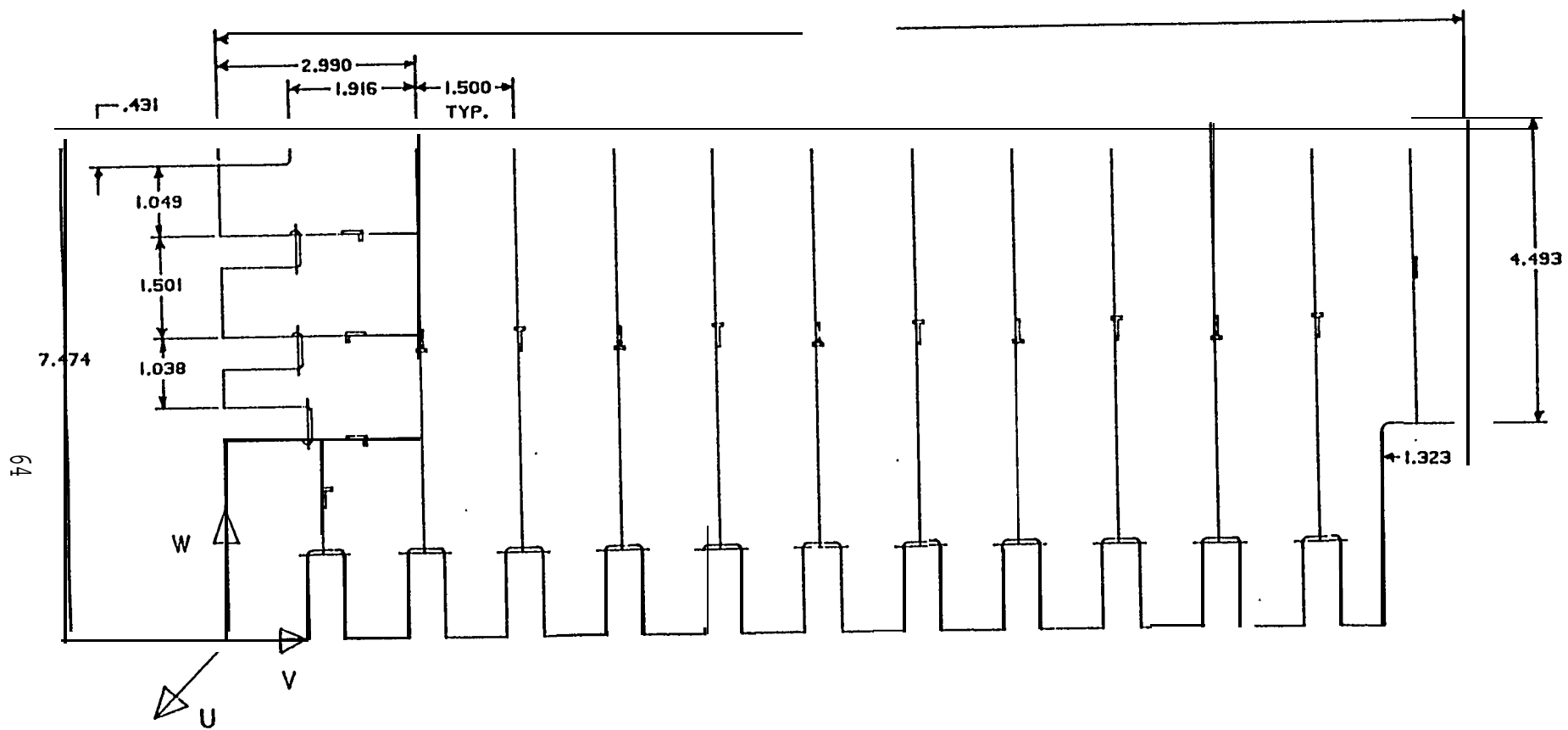
EXAMPLE: INSERT A SERIES OF CONNECTED LINES



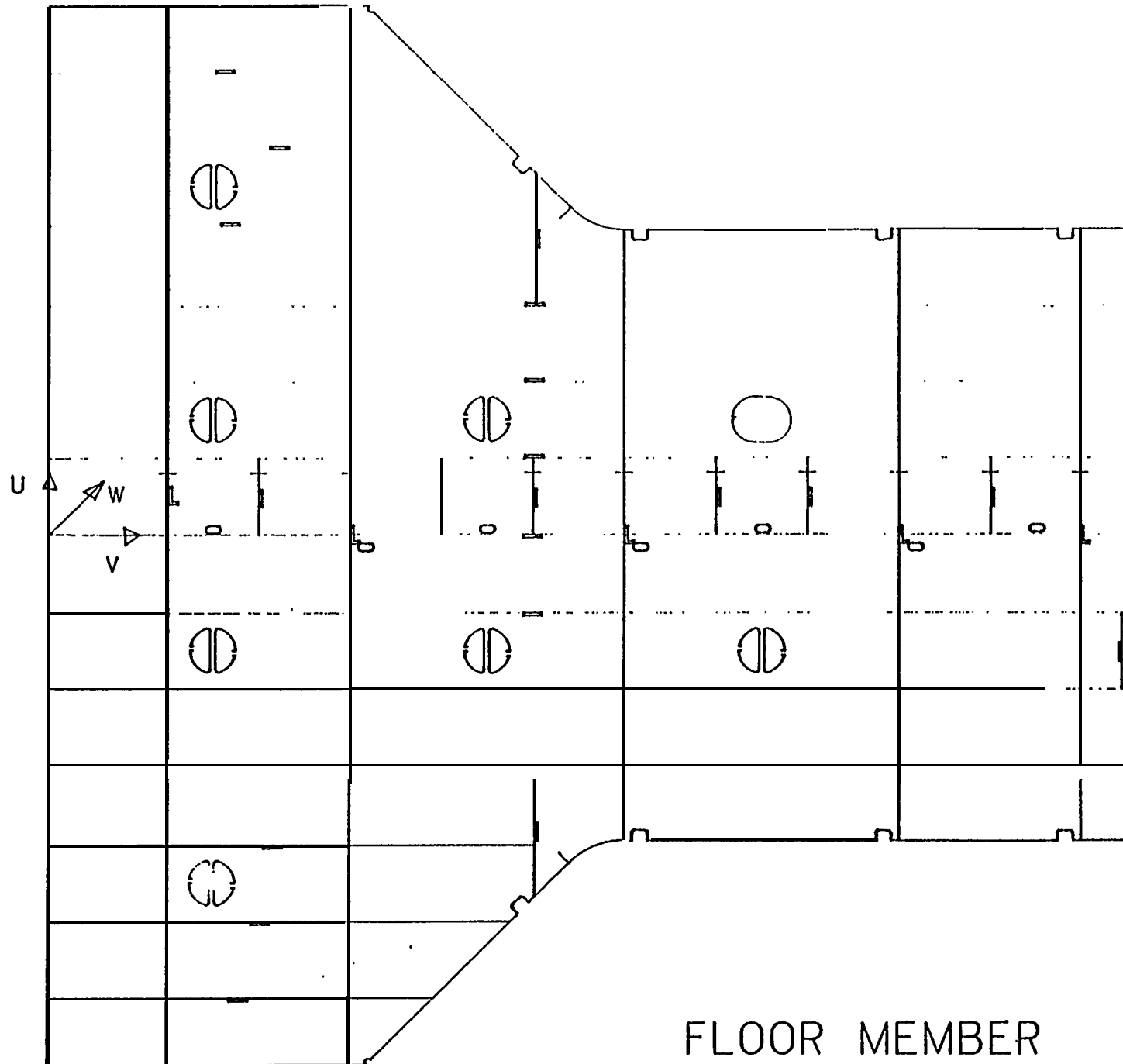
INS LIN: DIG, DIG<sub>2</sub> DIG<sub>3</sub> DIG<sub>4</sub>

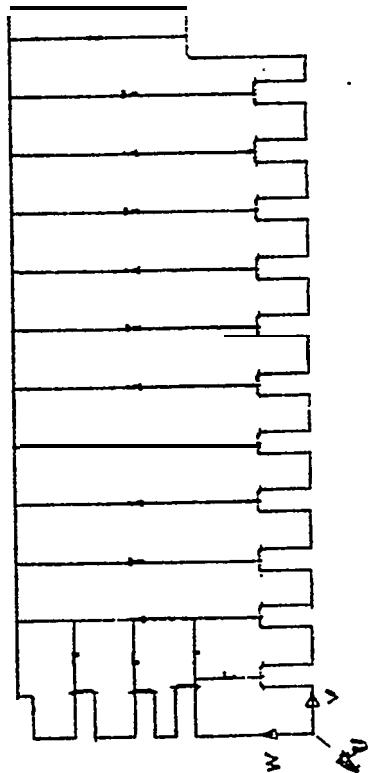
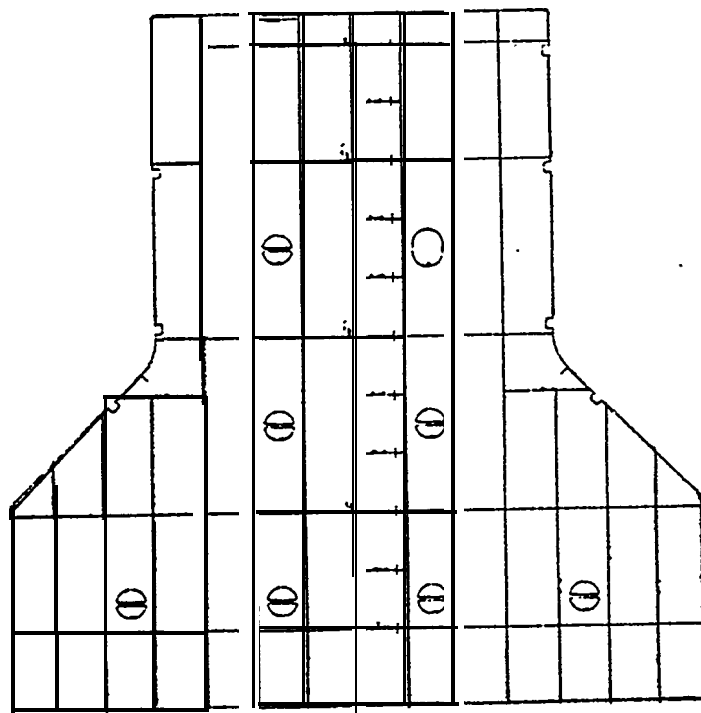
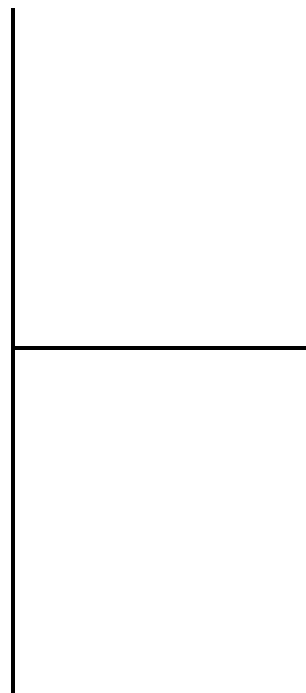
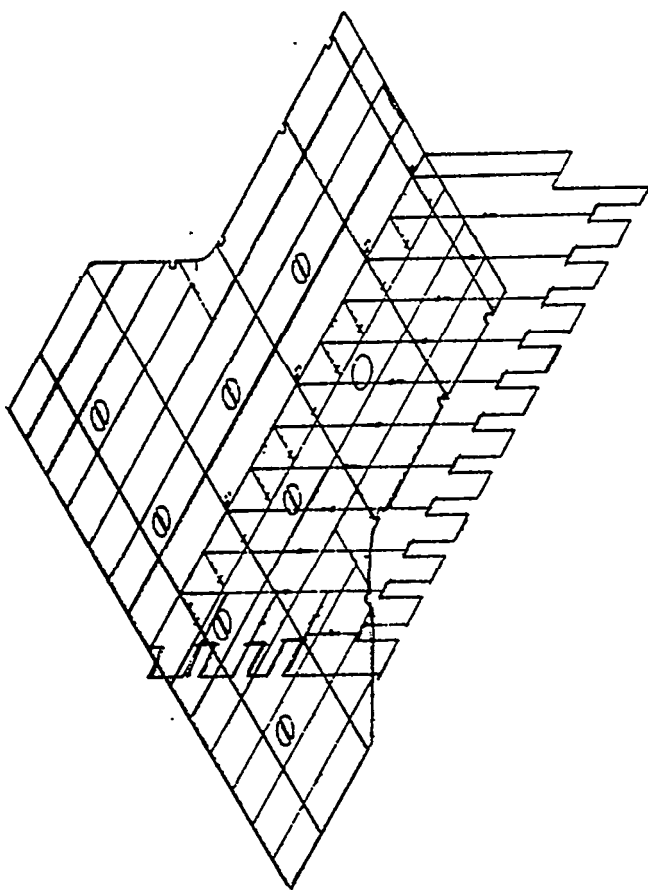


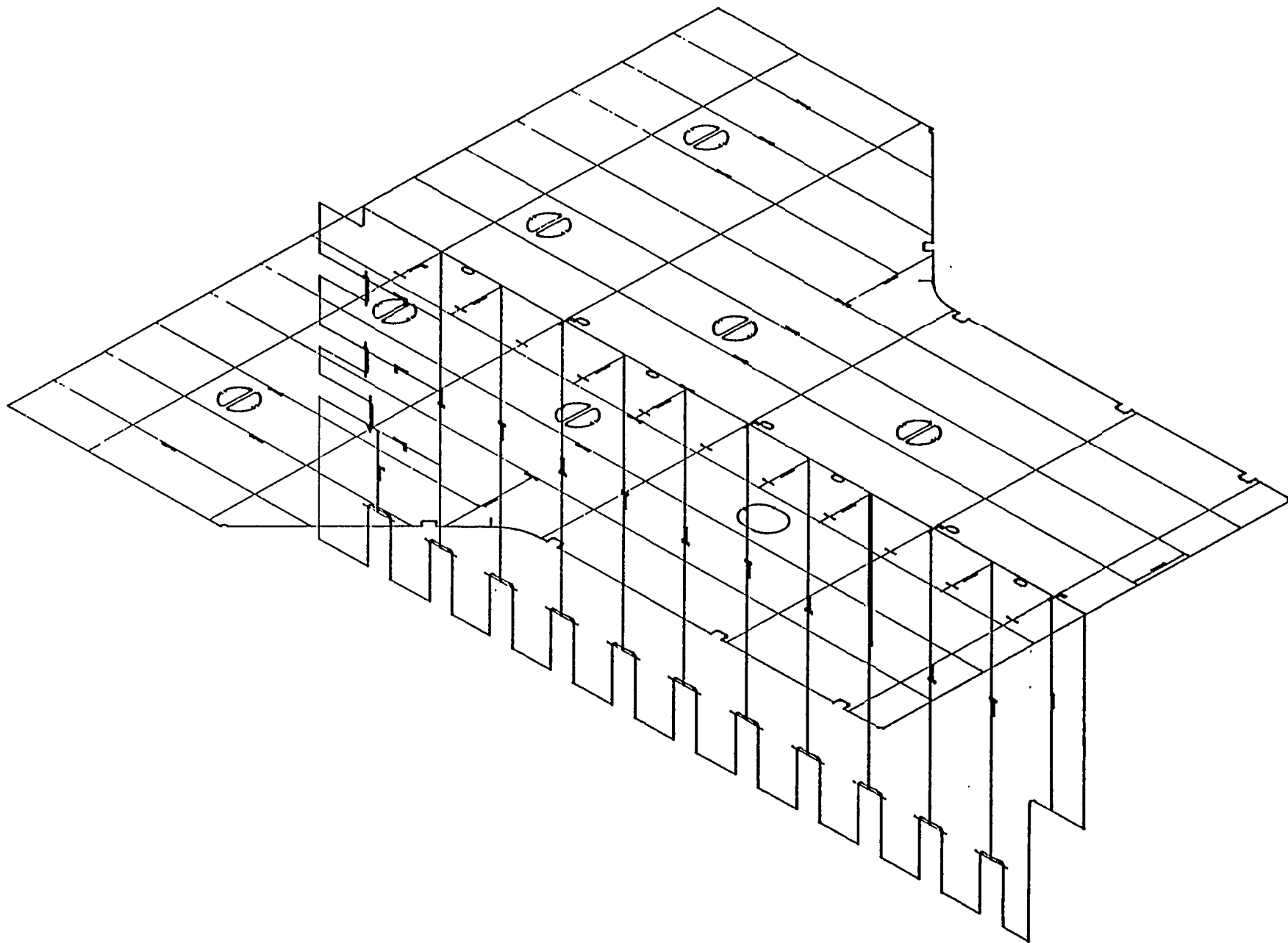
TYPICAL NORMS ENTERED USING PEP AND A  
COMBINATION OF PARAMETERS AND DIGITIZED DATA



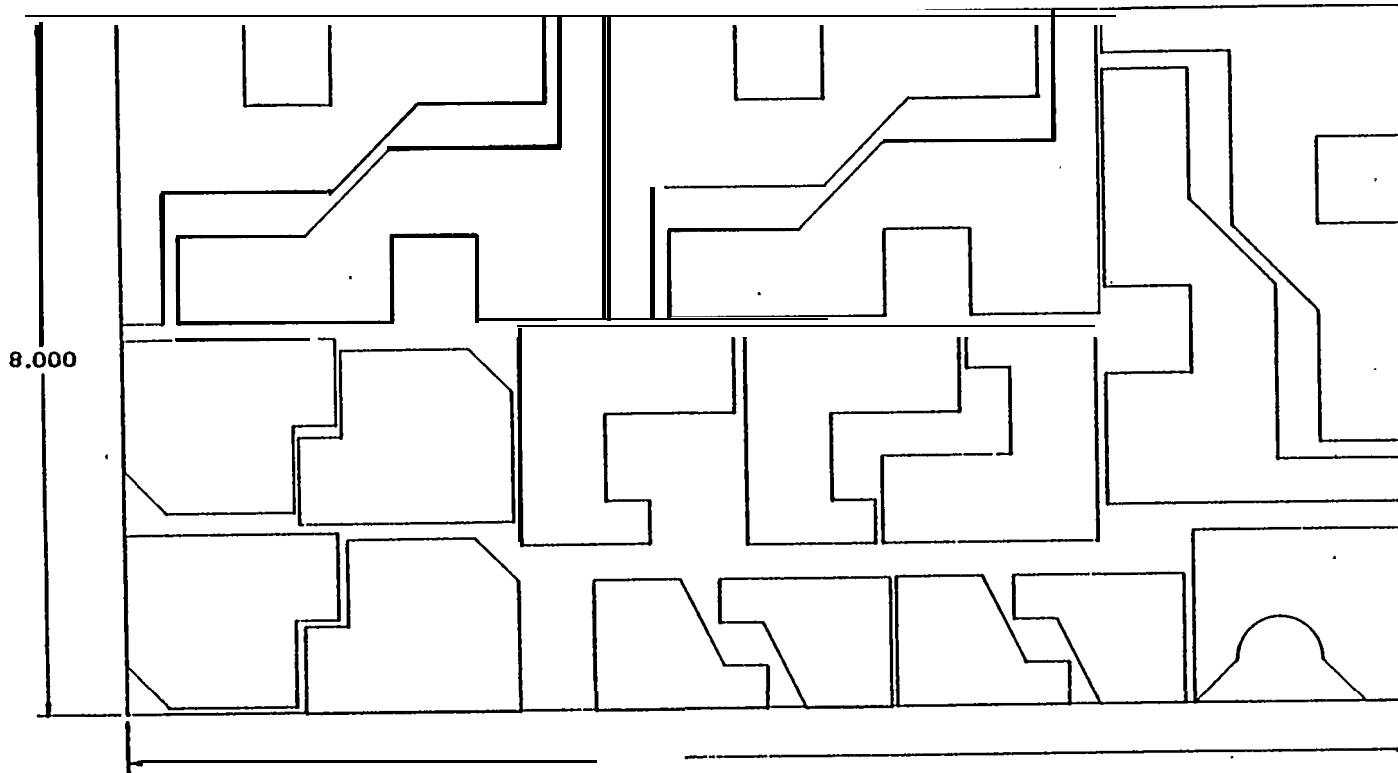
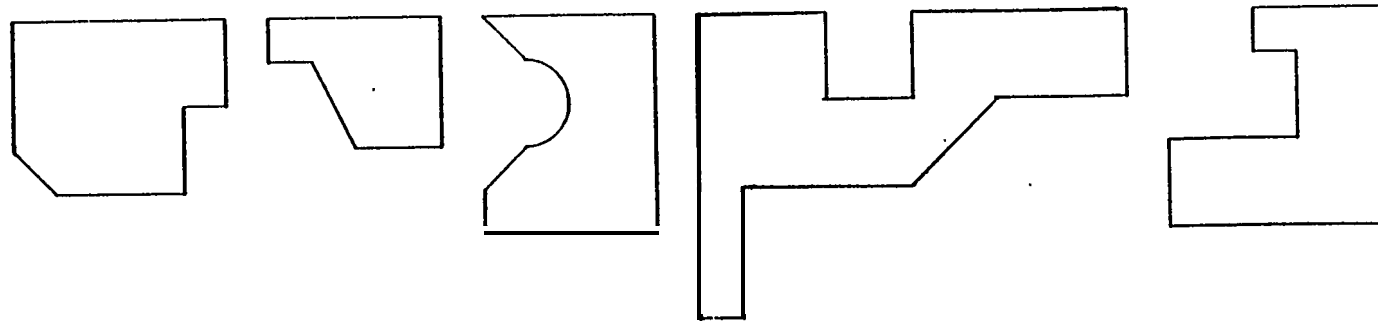
VERTICAL MEMBER







SOMETR C OF ASSEMBLY



89

PARTS NESTED ON CRT

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